SECTION 23 4133

HIGH-EFFICIENCY PARTICULATE FILTRATION

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LANL MASTER SPECIFICATION

When editing to suit project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the ESM Mechanical POC.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Information within “stars” is provided as guidance to the author responsible for revising the specification. Delete information within “stars” during editing.

This specification serves as a template. The specification was prepared by an organization operating under a quality assurance program that meets the requirements of 10 CFR 830 (suitable for ML-1 through ML-4 projects). Implementation of this specification requires modification to the specification to meet project-specific requirements. Responsibility for application of this specification to meet project-specific requirements lies with the organization modifying or implementing the specification. The organization modifying the specification shall apply a graded approach to quality assurance based on the management level designation of the project. When this specification is used with nuclear facilities subject to 10 CFR 830, modification to this specification must be performed by an individual or organization operating under a quality assurance program that meets the requirements of that CFR.

This specification serves as a template for procurement of filters at LANL. There is a list of filters that are pre-approved for use in LANL. The performance and design requirements for these filters can be found and referenced in Part 4 (attachments). If none of the pre-approved filters meet the performance or design requirements for a particular application, use this specification in its template format to procure a different filter.

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PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. ASME AG-1, Section FC HEPA Filters (Housings for these per Section 23 3225)
2. Auxiliary HEPA Filters and Housings

B. Related Sections

1. Section 23 3225 Bag-in Bag-out Housings

C. Applicability

1. This specification applies to filters for use in air and gas streams with a 250 degrees F maximum continuous temperature.

2. This specification applies to the procurement of filters for Department of Energy (DOE) facilities at Los Alamos National Laboratory.

1.2 REFERENCES

A. Follow Section 01 4219, Reference Standards

B. APA Engineered Wood Association

1. APA PS-1 (Form V995) Product Standard for Construction and Industrial Plywood.

C. American Society of Mechanical Engineers (ASME).

1. ASME AG-1, Section FC, HEPA Filters.
2. ASME Boiler and Pressure Vessel Code.
3. ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities.

D. ASTM International (ASTM; formerly American Society for Testing and Materials)

1. ASTM A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Application
2. ASTM A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
3. ASTM A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels, and for general application.
4. ASTM E2016, Standard Specification for Industrial Woven Wire Cloth
5. ASTM B16, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
6. ASTM B209, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
7. ASTM E84, Standard Test Method of Surface Burning Characteristics of Building Materials.
8. ASTM E499, Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector in Detector Probe Mode.

E. Institute of Environmental Sciences and Technology (IEST)

1. IEST-RP-CC001.3, HEPA and ULPA Filters.

F. International Organization for Standardization

1. ISO 9001, Quality Management Systems Requirements.

G. Department of Energy (DOE)

1. DOE-STD-3020, Specification for HEPA Filters Used by Contractors.
2. DOE-STD-3025, Quality Assurance Inspection and Testing of HEPA Filters.

H. Underwriter Laboratories

1. UL-586, Standard for High Efficiency Particulate Air Filter Units.

I. Code of Federal Register

1. 10 CFR 830.122, Quality Assurance.
2. 40 CFR 261, Identification and Listing of Hazardous Waste.

1.3 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

A. Acceptance Test: Inspection and testing of a filter to verify certain characteristics or properties, which determine the acceptance or rejection of that filter.

B. Approved Test Aerosol: Particle-generating materials approved by DOE and used as test aerosols for performing testing of HEPA filters.

C. ASME AG-1, Section FC HEPA Filters: Open faced, fire resistant, HEPA filters used in ventilation duct for use in nuclear air cleaning systems.

D. Auxiliary HEPA Filters: HEPA Filters that are not specifically addressed in ASME AG-1, section FC, such as sintered metal filters and round filters.

E. CMTR: Certified Material Test Report

F. CoC: Certificate of Conformance

G. EPA: Environmental Protection Agency

H. Filter Test Facility (FTF): A facility established by the DOE specifically to conduct performance tests and quality assurance inspections of HEPA filters.

I. High Efficiency Particulate Air (HEPA) Filter: A filter with a particle removal efficiency of at least 99.97 percent for 0.3 micrometer particles of an approved aerosol test.

J. Nominal Air Flow Rating: The flow rate which HEPA filters are identified by the manufacturer and confirmed at the FTF.

K. NPT: National Pipe Thread

L. Nuclear Facility: A DOE facility in which radioactive materials are produced or handled to the degree that environmental protection is required.

M. Penetration: The downstream test aerosol concentration, expressed as a percentage of the upstream test aerosol concentration.

N. PTFE: Polytetrafluoroethylene

O. QA: Quality Assurance

P. Qualification Test: A test, often destructive, of a prototype or randomly selected production filter to establish its capability to meet certain functional and specification requirements. The results of the test are considered to be typical of individual items or model number, which are of the same design and are manufactured by the same process.

Q. SST: Stainless steel

1.4 LANL PERFORMED WORK

A. LANL will do in-place penetration testing of HEPA filter(s) after successful installation in systems required to be tested.

1.5 SYSTEM DESCRIPTION

A. Design Requirements

1. ASME AG-1, Section FC HEPA Filters

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Edit Design Requirements as necessary for specific application.

Part 4 is an appendix of filters commonly used at LANL and their specific specifications. If using a filter from appendices 4.2, 4.3, or 4.4 that exactly matches what is needed, just specify the Model Number and Number Designation. If the filter needed does not exactly match those shown, transfer data from appendix to the correct section.

Type and number designation are defined in ASME AG-1, Section FC

- Type A – Folded filter media with corrugated separator/supports
- Type B – minipleat medium with glass fiber or noncombustible thread separators
- Type C – continuous corrugated filter media folded without separator
- Number Designation:

  1 – size: 8 in. x8 in. x3 1/16 in., min. rated air flow: 25 scfm, at 1.3 in. w.g. (max.)

  2 – size: 8 in. x8 in. x5 7/8 in., min. rated air flow: 50 scfm, at 1.3 in. w.g. (max.)

  3 – size: 12 in. x12 in. x5 7/8 in., min. rated air flow: 125 scfm, at 1.3 in. w.g. (max.)

  4 – size: 24 in. x24 in. x5 7/8 in. , min. rated air flow: 500 scfm, at 1.0 in. w.g. (max.)

  5 – size: 24 in. x24 in. x11 1/2 in. , min. rated air flow: 1000 scfm, at 1.0 in. w.g. (max.)

  6 – size: 24 in. x24 in. x11 1/2 in. , min. rated air flow: 1250 scfm, at 1.3 in. w.g. (max.)

  7 – size: 24 in. x24 in. x11 1/2 in. , min. rated air flow: 1500 scfm, at 1.3 in. w.g. (max.)

  8 – size: 24 in. x24 in. x11 1/2 in. , min. rated air flow: 2000 scfm, at 1.3 in. w.g. (max.)

  9 – size: 12 in. x12 in. x11 1/2 in. , min. rated air flow: 250 scfm, at 1.0 in. w.g. (max.)

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a. Design in accordance to ASME AG-1, Article FC-4000, Design

b. Type [A, B, or C]

c. Number Designation: [1 – 9, (note size, airflow, etc.)]

2. Auxiliary HEPA Filters

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Edit Design Requirements as necessary and add any additional criteria. Be sure to specify the following:

- Pressure differential at specified flow rate
- Housing leak tightness
- End fittings
- Overall dimensions

Part 4 is an appendix of filters commonly used at LANL and their specific specifications. If using a filter from the appendices, transfer data from appendix to the correct section or refer user to appendix for design requirements.

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a. Particle removal efficiency of 99.97 percent for 0.3 micrometers or better of an approved test aerosol.

b. Withstand a minimum pressure differential of 10 in. of water.

c. Pressure differential of less than [ ] in. of water at a flow rate of [ ] scfm.

d. [specify leak tightness of housing].

e. [specify end connections].

f. [specify overall dimensions].

1.6 SUBMITTALS

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Submittal of QA plan is not necessary if filter manufacturer is on the current LANL IESL (See QA-IQM web site).

Consider requiring CMTRs for custom fabricated filter housings.

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A. Submit the following in accordance with Section 01 3300, Submittal Procedures:

B. ASME AG-1, Section FC HEPA Filters

1. Certification documentation from an independent test facility indicating that HEPA filter model(s) have been successfully qualified in accordance with ASME AG-1, Article FC-5100 and Section 1.7.

2. COC that is signed or otherwise authenticated by responsible managers within the supplying organization and that certifies the conformance of end-items to order requirements. The Certificate of Conformance shall include:

a. Copy of the HEPA filter manufacturer's QA plan identifying procurement, fabrication, test & inspection, material traceability and non-conformity controls for approval

b. Statement that the products are constructed in accordance with the requirements in ASME AG-1, Section FC, manufacturer's QA plan and Section 1.7.

c. Qualification and Acceptance Test reports.

d. Purchased item identified by model number.

e. Purchase Order (PO) number.

f. Any approved changes, waivers, or deviations from this specification.

3. Warranty documentation - guarantee against failure in proper use or operation caused by defective materials and/or workmanship for a period of 1 year from the date of acceptance.

C. Auxiliary HEPA Filters

1. Certificate of Conformance that is signed or otherwise authenticated by responsible managers within the supplying organization and that certifies the conformance of end-items to order requirements. The Certificate of Conformance shall include:

a. Copy of the HEPA filter manufacturer's QA plan identifying procurement, fabrication, test & inspection, material traceability and non-conformity controls for approval.

b. Certification that filters and filter media have been designed, manufactured, and constructed in accordance with manufacturer's QA plan and Section 1.7.

c. Certification documentation showing that the filter meets the design requirements of Section 1.5, including material requirements of Section 2.3. Examples of such documents include: supplier performance test information, inspection reports, justification for design integrity, drawings, etc.

d. Certification that all custom-built filter housings are fabricated and leak tested to meet the requirements of this specification. Examples of such document include: personnel certification for welding, inspection and leak testing, leak test procedures and reports.

e. Purchased item identified by model number.

f. Statement that the filter housing meets the leak test requirements in Section 1.5.

g. Purchase Order (PO) number.

h. Any approved changes, waivers, or deviations from this specification

2. Installation Instructions

3. Warranty documentation - guarantee against failure in proper use or operation caused by defective materials and/or workmanship for a period of 1 year from the date of acceptance.

1.7 QUALITY ASSURANCE AND TESTING

A. ASME AG-1 Section FC HEPA Filters

1. Seller's Quality Assurance Requirements

a. Manufacture, inspect, test and ship under a quality assurance program meeting the applicable requirements of 10 CFR 830.122.

2. Seller's Qualification Testing requirements

a. Maintain all qualification certificates for filter models provided under this specification.

B. Auxiliary HEPA Filters

1. Seller's Quality Assurance Requirements

a. Develop, implement, and maintain an approved QA system (including program/plan, procedures, and process control documents) in accordance with 10 CFR 830.122. If the seller's QA plan is not in accordance with 10 CFR 830.122, then a LANL approved QA plan based on appropriate industry consensus standards such as ISO 9001 is acceptable.

1.8 PACKAGING AND SHIPPING

A. Package and ship ASME AG-1, Section FC HEPA filters per the requirements for level B items in accordance with ASME NQA-1 and:

1. Place filter cartons on an oversized pallet and secured or crated to eliminate unit handling at carrier inter change points and avoid unnecessary damage.

2. Do not stack HEPA filters more than three high.

3. For large shipments, ship the entire shipment in a sealed dedicated trailer or rail car to provide an additional quality assurance of product shipping and handling.

4. Ship filters properly orientated, as indicated on shipping container.

B. Package and ship Auxiliary HEPA filters per the following requirements:

1. Do not stack filters more than three high. It is acceptable to stack filters more than three high, if the individual filter does not exceed 24 inches in size, but the stacked height can not exceed 6 ½ feet.

2. Ship filters properly orientated, in accordance with manufacturer's recommendation.

PART 2 PRODUCTS

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ASME AG-1, Section FC regulated filters are designed specifically for use in nuclear facilities. For Auxiliary HEPA, consider filter environment when selecting acceptable materials. Example: PTFE may not be an acceptable material for a radiation environment. Also note, the listing of

materials for Auxiliary HEPA filters is not a complete list of possible materials, others may be acceptable. Again, carefully consider the environment (corrosion, radiation, etc) in which the filter will be operating.

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2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. No substitutions allowed.

2.2 MANUFACTURERS

A. ASME AG-1, Section FC HEPA Filters

1. The following is a list of some of the manufacturers with qualified nuclear grade HEPA filter products that may meet the requirements of this specification and ASME AG-1, Section FC. However, these manufacturers are not exempt from any seller requirements including the submission of qualification certification for approval.

a. AAF International (American Air Filter)

b. Camfil Farr, Inc.

c. Flanders Filters, Inc.

B. Auxiliary HEPA Filters

1. The following is a list of some of the manufacturers. in addition to those above, with HEPA equivalent or better filters that may meet the requirements of this specification. However, these manufacturers are not exempt from any seller requirements including the submission of qualification certification for approval.

a. Pall

2.3 MATERIALS OF CONSTRUCTION

A. General

1. The following are not acceptable materials of construction:

a. Particle board

b. Asbestos

c. Cadmium-coated metals

d. Any material that generates EPA regulated wastes as specified in 40 CFR 261.

B. Filter Media

1. ASME AG-1, Section FC HEPA Filters

a. Manufacture silicate media in accordance with Article I-3000 of ASME AG-1, Appendix FC-I.

2. Auxiliary HEPA Filters

a. Non-woven glass fiber paper

b. Sintered metal, such as stainless steel, nickel and Hasteloy.

c. Ceramic

d. PTFE

C. Case

1. ASME AG-1, Section FC HEPA Filters

a. Type 304 or 316 stainless steel, minimum 14 gauge, conforming to ASTM A240.

b. Plywood, 3/4 in. thick conforming to minimum grade A-C, APA PS-1 (Form V995). The grade shall be fire retardant treated. The plywood shall have a flame spread classification of 25 or less when tested in accordance with ASTM E 84.

D. Housing

1. Auxiliary HEPA Filters

a. Type 300 series stainless steel, minimum 16 gauge, conforming to ASTM A240, ASTM A479, or ASTM A312.

b. Plywood, 3/4 in. thick conforming to minimum grade A-C, APA PS-1 (Form V995). The grade shall be fire retardant treated. The plywood shall have a flame spread classification of 25 or less when tested in accordance with ASTM E 84. This material is not allowed for circular filters.

E. Separators (when used)

1. Aluminum, minimum 0.0015 in. thickness with or without coating, conforming to ASME AG-1, Article FC-3160.

F. Adhesives

1. Used to splice the media, fasten gaskets to filter frame, and seal the filter pack or faceguards to the frame

a. Self-extinguishing in accordance with the spot-flame test of ASME AG-1, Article FC-5160 or UL 586.

G. Gaskets and Seals

1. ASME AG-1, Section FC HEPA Filters

a. Flat Gaskets – in accordance with DOE-STD-3020-2005 (Section 5.3.5.1).

b. Fluid Seals – in accordance with DOE-STD-3020-2005 (Section 5.3.5.2).

2. Auxiliary HEPA Filters

    a. Elastomer - in accordance with ASME AG-1, Article FK-3121.

    b. Gelatinous Seal – in accordance with ASME AG-1, Article FK-3122.

H. Faceguards (when used)

1. Provide faceguards on each face of all filter number designations 4 through 8 [faceguards may be specified on other filter number designations.]
2. Provide faceguards in accordance with ASME AG-1, Article FC-3140.
3. For highly-corrosive atmospheres provide faceguards fabricated from Type 304 stainless steel 4x4 mesh and wire fabric conforming to ASTM E2016.

2.4 FABRICATION

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Add additional fabrication requirements as necessary, such as welding. Be sure to specify leak tightness and end connections for Auxiliary Filters.

Part 4 is an appendix of filters commonly used at LANL and their specific specifications. If using a filter from the appendices, transfer data from appendix to the correct section or refer user to appendix for additional fabrication requirements.

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A. General

1. ASME AG-1, Section FC HEPA Filters

    a. Fabricate in accordance with ASME AG-1, Article FC-6000 and 10 CFR 830.122.

    b. Filters with separators shall have the separators fully attached to the top and bottom of the case along the entire length of the separators.

    c. Label each filter and shipping container in accordance with ASME AG-1, Article FC-9000.

2. Auxiliary HEPA Filters and housing

    a. Fabricate in accordance with manufacturer’s approved QA plan.

    b. Assemble filter from materials designated in Section 2.3.

    c. Do not patch holes or tears in filter media.

    d. Ensure that filter is free from foreign matter and damage.

    e. Fabricate housing to [specify leak tightness].

    f. Provide [specify end connections].

    g. Label each filter with the following minimum information.

1. Manufacture's name
2. Model number
3. Serial number
4. Rated flow capacity
5. Pressure drop, in inches of water at 100% rated flow
6. Overall penetration at rated flow
7. UL label indicating successful testing per UL 586 if applicable.

2.5 SOURCE QUALITY CONTROL

A. Qualification and Acceptance Test Criteria

1. ASME AG-1, Section FC HEPA Filters

a. Perform qualification testing of filters and filter media by an independent test facility in accordance with ASME AG-1, Article FC-5100.

b. Perform factory production testing of aerosol penetration and resistance to air flow in accordance with ASME AG-1, Article FC-5200.

c. Perform acceptance testing of filter by an FTF (Air Techniques International Testing Laboratories, Suite 104, 1708 Whitehead Rd., Baltimore, MD 21207, phone 410-277-8981, fax 410-277-3448, email ATITL@atitest.com) in accordance with ASME AG-1, Article FC-5200 and DOE-STD-3025-99.

2. Auxiliary HEPA Filters

a. Perform qualification testing of filters by an independent test facility in accordance with ASME AG-1, Article FK-5000.

b. Perform factory production testing in the following categories:

1. Penetration – Test with DOE- approved aerosol and test method or the particle counter scanning method as described in IEST-RP-CC001.3. If penetration of 0.3 micrometers exceeds 0.03 percent, filter is not acceptable.

2. Resistance to airflow – The clean filter resistance to airflow shall meet the requirements of Section 1. 5 A2.

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Leak testing is only required for filters with end plates and nipple connections.

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3. Leak testing – Perform helium leak test in accordance with ASTM E499 or perform bubble leak testing in accordance with ASME Boiler and Pressure Vessel Code, Section V, Article 10.

c. Perform acceptance testing of filters by an FTF (Air Techniques International Testing Laboratories, Suite 104, 1708 Whitehead Rd., Baltimore, MD 21207, phone 410-277-8981, fax 410-277-3448, email ATITL@ atitest.com) in accordance with ASME AG-1, Article FK-5600.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect all filters upon shipment receipt and before installation for visual damage such as cracks, tears in filter media or dents in housing. Inspect gaskets for cracking or other signs of degradation. Verify documentation from Section 1.6 is included and is complete.

3.2 STORAGE

A. Store ASME AG-1, Section FC HEPA filters per the requirements for level B items in accordance with ASME NQA-1 or in accordance with the manufacturer's requirements, which ever is more restrictive and :

1. Do not stack HEPA filters more than three high.
2. Store filters properly orientated, as indicated on shipping container.
3. Do not store filters for more than 10 years after manufacture date. If filter has been in storage for greater than 3 years, visually inspect gaskets for cracks, before installation.

B. Store auxiliary HEPA filters in accordance with the manufacturer's requirements and:

1. Do not stack filters more than three high. It is acceptable to stack filters more than 3 high if the individual filter does not exceed 24 in. in size, but the stacked height can not exceed 6 ½ feet.
2. Store filters properly orientated, in accordance with manufacturer's recommendations.
3. Do not store filters for more than 10 years after manufacture date. If filter has been in storage for more than 3 years, visually inspect filter unit, especially seals for damage before installation.

3.3 INSTALLATION

A. Install per manufacturer's instructions.

3.4 FIELD QUALITY CONTROL

A. Test ASME HEPA filters after installation for penetration in accordance with LANL requirements.

B. Test Auxiliary HEPA filters (when required) after installation for penetration in accordance with LANL requirements.

C. Replace all filters that fail LANL in-place penetration test.

D. Notify Seller, SUP, and PS-1 of filter rejections and re-evaluate the future procurement status of that manufacturer and/or model.

PART 4 ATTACHMENTS

4.1 ASME AG-1, SECTION FC HEPA Filter – American Air Filter, Qualified Nuclear Grade HEPA Filters

4.2 ASME AG-1, SECTION FC HEPA Filter – Camfill Farr, Qualified Nuclear Grade HEPA Filters

4.3 ASME AG-1, SECTION FC HEPA Filter – Flanders Filters, Qualified Nuclear Grade HEPA Filters

4.4 Auxiliary HEPA Filter – Flanders Filters, 4 in. Round

END OF SECTION

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Do not delete the following reference information:

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FOR LANL USE ONLY

This project specification is based on LANL Master Specification 23 4133 Rev. 0, dated January 10, 2006.

ATTACHMENT 4.1

ASME AG-1, Section HEPA Filter – American Air Filter, Qualified Nuclear Grade HEPA Filters

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Variations listed within brackets are qualified filter configurations. Consult with filter manufacturer for suffix number (xxx) of specific filter configuration.

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A. Model Number: 105-1332345-XXX. (Qualified on 1/28/2005. Qualification expires on 1/28/2010). Type A, Number Designation 1 through 7, and 9, but excluding 4.

   1. Materials (Section 2.3 B-H)

      a. Filter media –Lydall # 3398 or Hollingswoth & Vose # 7583

      b. Case – box type construction, 3/4 inch fire-retardant plywood

      c. Separator – [corrugated aluminum] or [corrugated vinyl coated aluminum]

      d. Adhesive – polyurethane

      e. Gasket – [neoprene gasket on upstream face] or [neoprene gasket on downstream face] or [none]

      f. Faceguard – [galvanized hardware cloth on both faces] or [Type 304 SST hardware cloth on both faces]

ATTACHMENT 4.2

ASME AG-1, Section FC HEPA Filter – Camfil Farr, Qualified Nuclear Grade HEPA Filters

A. Model Number: 01ES-24Z24Z06-4D-2-F-M-1B-0/00, Part Number 855210317 (Qualified on 3/27/2003. Qualification expires on 3/27/2008.) Type A, Number Designation 1 through 4.
    1. Materials (Section 2.3 B-H)
        a. Filter media – micro glass, acrylic resin binder, qualified per ASME AG-1, Section FC-1.
        b. Case – 14 gauge 304 SST
        c. Separator – corrugated aluminum
        d. Adhesive – fire retardant, phosphorus free 2 part polyurethane
        e. Gasket – gel seal on downstream face.
        f. Faceguard – galvanized steel hardware cloth on both sides

B. Model Number: 01ES-24Z24Z06-BD-2-F-M-1B-0/00, Part Number 855210318 (Qualified on 3/27/2003. Qualification expires on 3/27/2008.) Type A, Number Designation 1 through 4.
    1. Materials (Section 2.3 B-H)
        a. Filter media – micro glass, acrylic resin binder, qualified per ASME AG-1, Section FC-1.
        b. Case – 14 gauge 304 SST
        c. Separator – corrugated aluminum
        d. Adhesive – fire retardant, phosphorus free 2 part polyurethane
        e. Gasket – neoprene gasket on downstream face
        f. Faceguard – galvanized steel hardware cloth on both sides

C. Model Number: 01ES-24Z24Z12-4D-3-F-M-1B-0/00, Part Number 855210319 (Qualified on 3/27/2003. Qualification expires on 3/27/2008.) Type A, Number Designation 5 through 7, and 9.
    1. Materials (Section 2.3 B-H)
        a. Filter media – micro glass, acrylic resin binder, qualified per ASME AG-1, Section FC-1.
        b. Case – 14 gauge 304 SST
        c. Separator – corrugated aluminum
        d. Adhesive – fire retardant, phosphorus free 2 part polyurethane
        e. Gasket – gel seal on downstream face

f. Faceguard – galvanized steel hardware cloth on both sides

D. Model Number: 01ES-24Z24Z12-BD-3-F-M-1B-0/00, Part Number 855210320 (Qualified on 3/27/2003. Qualification expires on 3/27/2008.) Type A, Number Designation 5 through 7, and 9.

1. Materials (Section 2.3 B-H)

a. Filter media – micro glass, acrylic resin binder, qualified per ASME AG-1, Section FC-1.

b. Case – 14 gauge 304 SST

c. Separator – corrugated aluminum

d. Adhesive – fire retardant, phosphorus free 2 part polyurethane

e. Gasket – neoprene gasket on downstream face

f. Faceguard – galvanized steel hardware cloth on both sides

ATTACHMENT 4.3

ASME AG-1, Section FC HEPA Filter – Flanders Filters, Qualified Nuclear Grade HEPA Filters

A. Model Number: 0-007-C-04-00-NU-11-13-GG-FU5 (Qualified on 1/2/2002. Qualification expires on 1/2/2007.) Type A, Number Designation 1 through 7, and 9, but excluding 4.
    1. Materials (Section 2.3 B-H)
        a. Filter media – pleated flat sheet non-woven glass paper (boron silicate micro fiber), 99.97 percent minimum efficiency
        b. Case – box-type construction, 3/4 in. fire-retardant plywood
        c. Separator – corrugated aluminum
        d. Adhesive – fire-retardant solid urethane
        e. Gasket – neoprene on upstream face
        f. Faceguard – galvanized steel hardware cloth on both faces

B. Model Number: T-007-W-04-05-NU-51-13-GG-FU5 (Qualified on 1/2/2002. Qualification expires on 1/2/2007.) Type C, Number Designation 1 through 7, and 9, but excluding 4.
    1. Materials (Section 2.3 B-H)
        a. Filter media – 11 in. deep PUREFORM® filter pack, non-woven glass paper (boron silicate micro fiber), 99.97 percent minimum efficiency
        b. Case – box-type construction, 3/4 in. fire-retardant plywood
        c. Separator – none
        d. Adhesive – fire-retardant solid urethane
        e. Gasket – BLUE-JEL® seal on upstream face
        f. Faceguard – galvanized steel hardware cloth on both faces

C. Model Number: 0-007-W-43-03-NU-11-23-GG-FU5 (Qualified on 04/17/03. Qualification expires on 04/17/08.) Type C, Number Designation: 1 through 7, and 9, but excluding 4.
    1. Materials (Section 2.3 B-H)
        a. Filter media – 11 in. deep PUREFORM® filter pack, non-woven glass paper (boron silicate micro fiber), 99.97 percent minimum efficiency.
        b. Case – bolted construction with double-turn flanges on both faces, 14 gauge Type 304 SST.
        c. Separator – none
        d. Adhesive – fire-retardant solid urethane
        e. Gasket – neoprene on upstream face

f. Faceguard – galvanized steel hardware cloth on both faces

D. Model Number: T-007-U-43-05-NU-51-23-GG-FU5 (Qualified on 05/28/04. Qualification expires on 05/28/09) Type C, Number Designation: 1 through 7, and 9, but excluding 4.

1. Materials (Section 2.3 B-H)

a. Filter media – 11 in. deep DYN-E2® filter pack, non-woven glass paper (boron silicate micro fiber), 99.97 percent minimum efficiency.

b. Case – bolted construction with double-turn flange on one face and fluid seal groove on opposite face, 14 gauge Type 304 SST.

c. Separator – none

d. Adhesive – fire-retardant solid urethane

e. Gasket – BLU-JEL® on upstream face

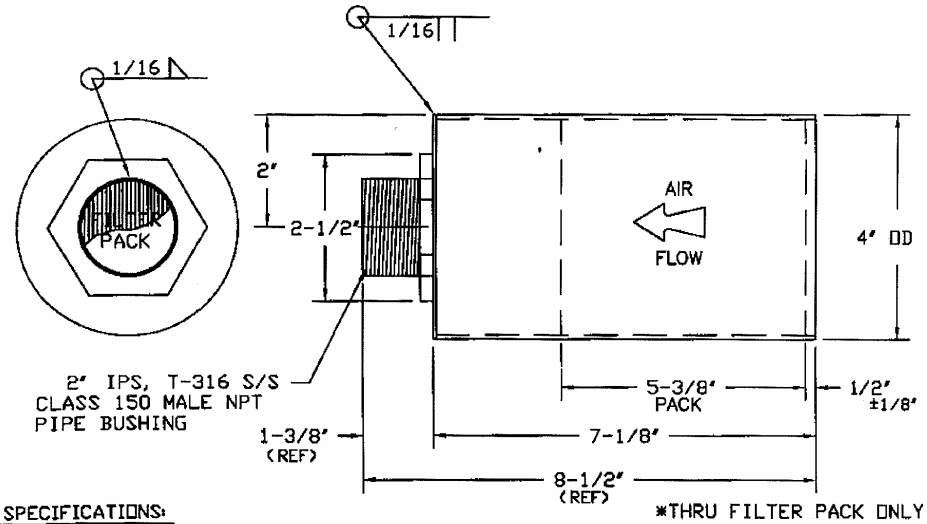
f. Faceguard – stainless steel hardware cloth on both faces

ATTACHMENT 4.4

Auxiliary HEPA Filter – Flanders Filters, 4 inches Round

A. Model number: 0-007-C-15-N1-NU-00-00-Z99436E. Open inlet, 2” IPS class 150 Male NPT pipe bushing on outlet. See attached FLANDERS FILTERS drawing Z99436 Rev E.

B. Model Number: 0-007-C-15-N1-NU-00-22-Z03010A. 2” IPS class 150 Male NPT pipe bushing on inlet, open outlet with faceguard. See attached FLANDERS FILTERS drawing Z03010 Rev A.



CAUTION: WHEN AIRFLOW IS HORIZONTAL FILTER SHOULD BE INSTALLED WITH PLEATS RUNNING IN VERTICAL DIRECTION

NO PATCHING OF MEDIA

NOTE:
BUBBLE TEST ALL PRESSURE BOUNDARY SEAMS AT OPERATING FLOW PER MFG. INSTRUCTION ITP-152.

DRAWING FOR RECORD PURPOSES ONLY

REV	DESCRIPTION	DATE	APPR
E	UPDATED TEST SPECIFICATIONS	1/24/05 WEA	SW ACL
D	UPDATED BORDER	10/15/03 WEA	SW XZW
C	ADDED UL586	1/28/02 WEA	ACL SW
B	DELETED WELD ON NIPPLE HEX NUT	12/20/01 WEA	ACL SW
A	WAS 'IU', ME-F0711 MEDIUM	9/13/01 WEA	JHL AL

SPECIFICATIONS:

*THRU FILTER PACK ONLY

FILTER SHALL BE MODEL #0-007-C-15-N1-NU-00-00-Z99436E AS MANUFACTURED BY FLANDERS FILTERS. IT SHALL BE TESTED AND CERTIFIED TO BE NOT LESS THAN 99.97 % EFFICIENT, FOR PARTICLES OF CRITICAL SIZE 0.3 µm. THE INITIAL RESISTANCE TO AIR FLOW WILL BE A MAXIMUM *3.0 "W. G. AT *35 CFM
THE MAXIMUM OPERATING TEMPERATURE IS 250 °F MAX. R. H. 100 %.

A. FRAME HARDWARE NONE
B. MEDIUM FLATSHEET (ME-FN700)
C. PACK STYLE ALUMINUM SEPARATORS
D. FRAME MATERIAL 4" OD. 0.065 WALL 316L S/S TUBING
F. FRAME STYLE ONE (1) NIPPLE
G. PACK TO FRAME SEALANT F.R. SOLID URETHANE
H. GASKET/SEAL MATERIAL NONE LOCATION NONE JOINT
I. FACEGUARD MATERIAL NONE LOCATION NONE

TESTING SPECIFICATIONS:

TEST DETAILS	TEST FLOWS	DESIGN QUALIFICATION
■ Q-107 / DOP OR ■ DUAL LASER / PSL	■ ENCAPSULATED	■ ASME/AG-1 SECTION FC 3000
	■ 100% FLOW	□ ASME/AG-1 SECTION FC 4000
	□ 20% FLOW	□ ASME/AG-1 SECTION FC 5000
□ OTHER	□ OTHERS	■ UL-586

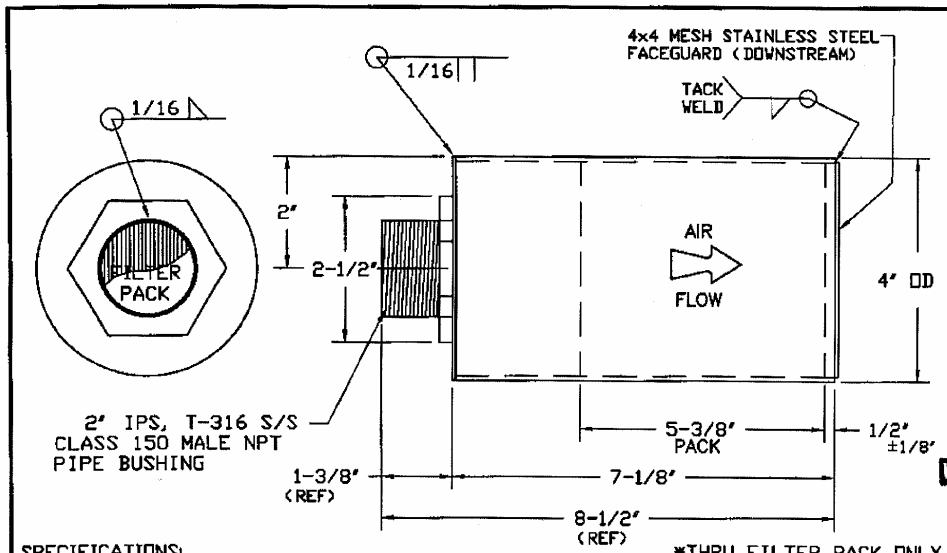
FFI ITEM NO.: F0616140
FFI EXTRUSION NO.:

CUSTOMER
CUSTOMER ORDER NO.
FLANDERS ORDER NO.

		DATE	SCALE
DR:	D. PRICE	12/20/99	N.T.S.
CK:	S. Wendley	12/20/99	TOL.
APPR:	S. Wendley	12/22/99	±1/16"

MODEL NO.
0-007-C-15-N1-NU-00-00-Z99436E

FLANDERS FILTERS, INC. WASHINGTON, N.C.	DRAWING NO. Z99436	REV. E



CAUTION: WHEN AIRFLOW IS HORIZONTAL FILTER SHOULD BE INSTALLED WITH PLEATS RUNNING IN VERTICAL DIRECTION

NO PATCHING OF MEDIA

NOTE:
BUBBLE TEST ALL PRESSURE BOUNDARY SEAMS AT OPERATING FLOW PER MFG. INSTRUCTION ITP-152.

DRAWING REQUIRES UPDATE TO REV. A FOR UPDATING "TEST SPECIFICATIONS:" TO "SAME AS" DWG Z99436E
CJW 9/00/05

DRAWING FOR RECORD PURPOSES ONLY

SPECIFICATIONS:

*THRU FILTER PACK ONLY

FILTER SHALL BE MODEL #0-007-C-15-N1-NU-00-22-Z03010A AS MANUFACTURED BY FLANDERS FILTERS. IT SHALL BE TESTED AND CERTIFIED TO BE NOT LESS THAN 99.97 % EFFICIENT, FOR PARTICLES OF CRITICAL SIZE 0.3 µm. THE INITIAL RESISTANCE TO AIR FLOW WILL BE A MAXIMUM *3.0 "W. G. AT *35 CFM THE MAXIMUM OPERATING TEMPERATURE IS 250 °F MAX. R. H. 100 %.

CJW 9/00/05

A. FRAME HARDWARE NONE
B. MEDIUM 007 FLAT SHEET (ME-FN700)
C. PACK STYLE ALUMINUM SEPARATORS
D. FRAME MATERIAL 4" OD. 0.065" WALL 316L STAINLESS STEEL TUBING
F. FRAME STYLE ONE (1) NIPPLE
G. PACK TO FRAME SEALANT F.R. SOLID URETHANE
H. GASKET/SEAL MATERIAL NONE LOCATION NONE JOINT
I. FACEGUARD MATERIAL 4x4 MESH STAINLESS STEEL LOCATION DOWNSTREAM

TESTING SPECIFICATIONS:

CHALLENGE
☒ DOP
☐ PAO

PENETROMETER
☒ Q-107
☐ DUAL LASER (HFATS)

TEST FLOWS
☐ ENCAPSULATED
☒ 100% FLOW
☐ 20% FLOW
☐ OTHERS

DESIGN QUALIFICATION
☒ ASME/AG-1 SECTION FC 3000
☐ ASME/AG-1 SECTION FC 4000
☐ ASME/AG-1 SECTION FC 5000
☒ UL-586

REV	DESCRIPTION	DATE	APPR

FFI ITEM NO.: F0621844
FFI EXTRUSION NO.:

CUSTOMER [illegible]
CUSTOMER ORDER NO.
FLANDERS ORDER NO.

	DATE	SCALE
DR: W. ASBELL	3/6/03	N.T.S.
CK: S. Windley	3/6/03	TOL.
APPR: L.E. Haggard	3/6/03	±1/16"

MODEL NO.
0-007-C-15-N1-NU-00-22-Z03010A

FLANDERS FILTERS, INC. WASHINGTON, N.C.

DRAWING NO. Z03010

REV. A

CJW 9/00/05